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# ***ISS Microgravity Requirements***

**Microgravity Environment Interpretation Tutorial  
NASA Glenn Research Center  
March 6-8, 2001**

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## Presentation Overview

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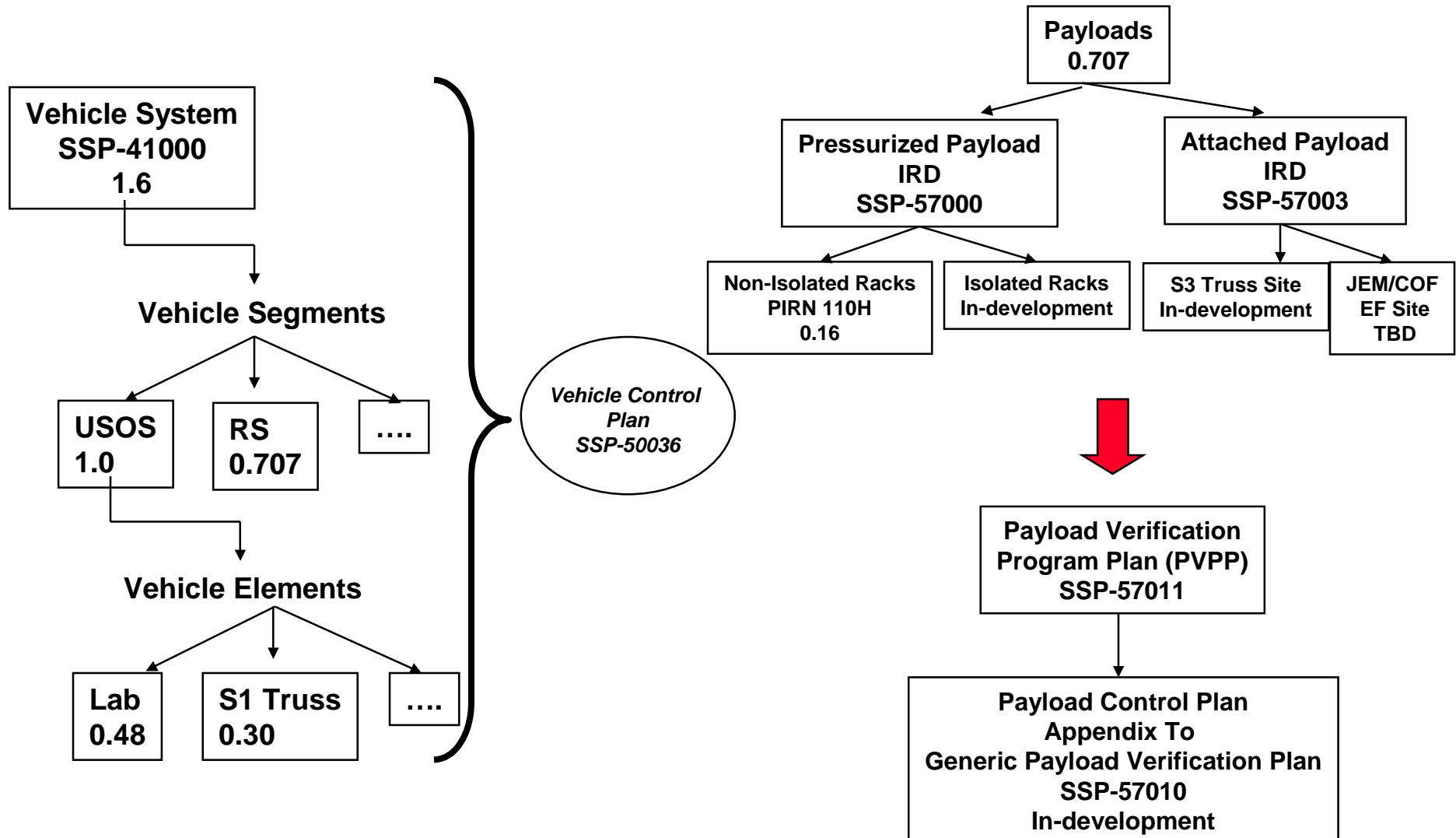


# REQUIREMENTS

- **Flow-down/Verification**
- **Vehicle**
- **Payloads**

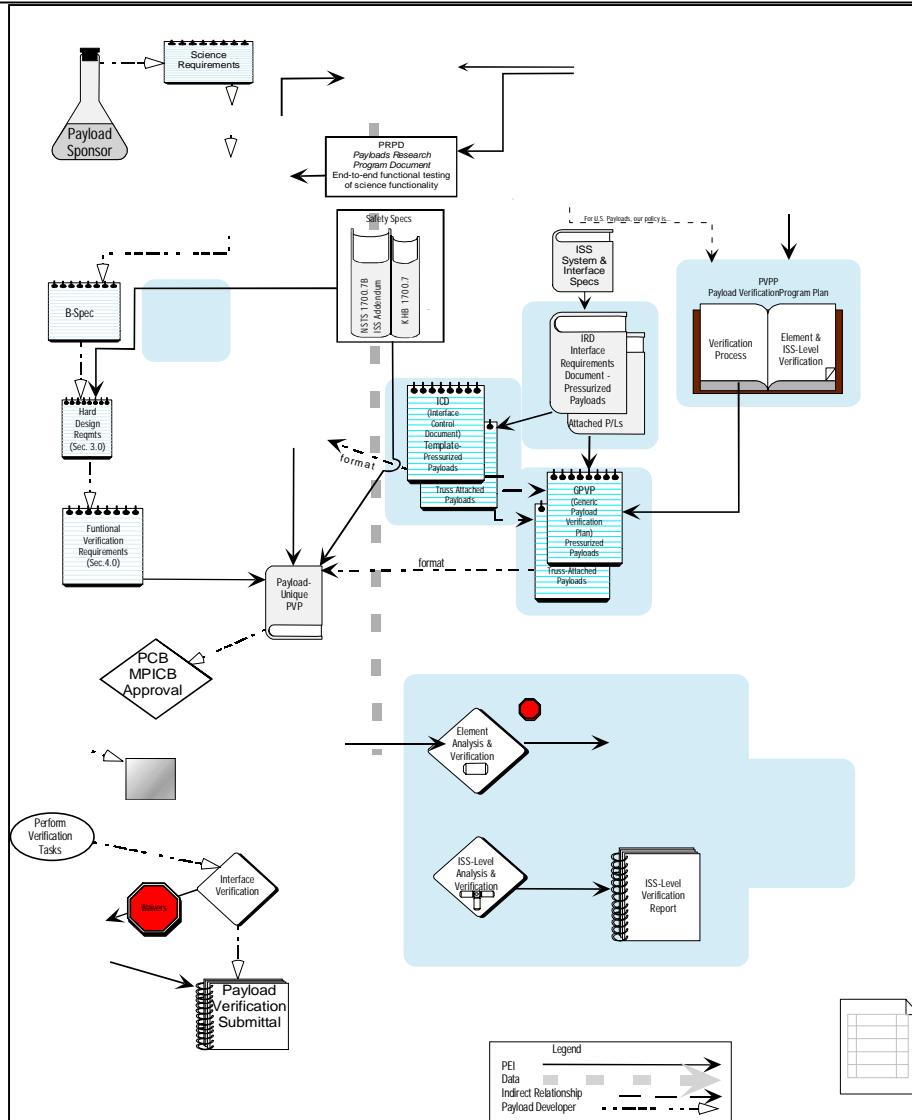


## Microgravity Requirement Architecture



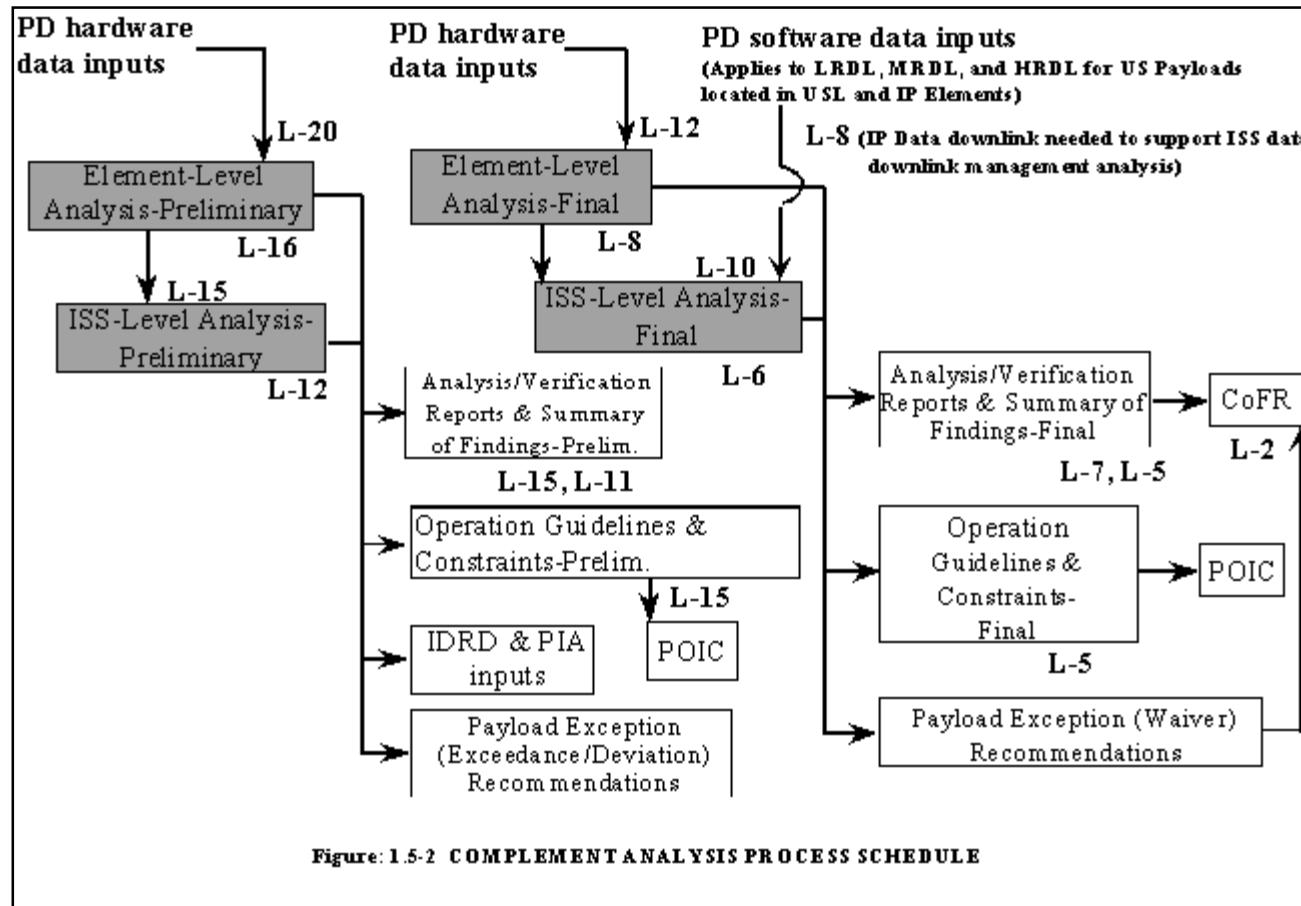


# PAYLOAD REQUIREMENT VERIFICATION FLOW





# PAYLOAD REQUIREMENT ELEMENT LEVEL VERIFICATION





## PAYOUT ELEMENT LEVEL VERIFICATION FLOW

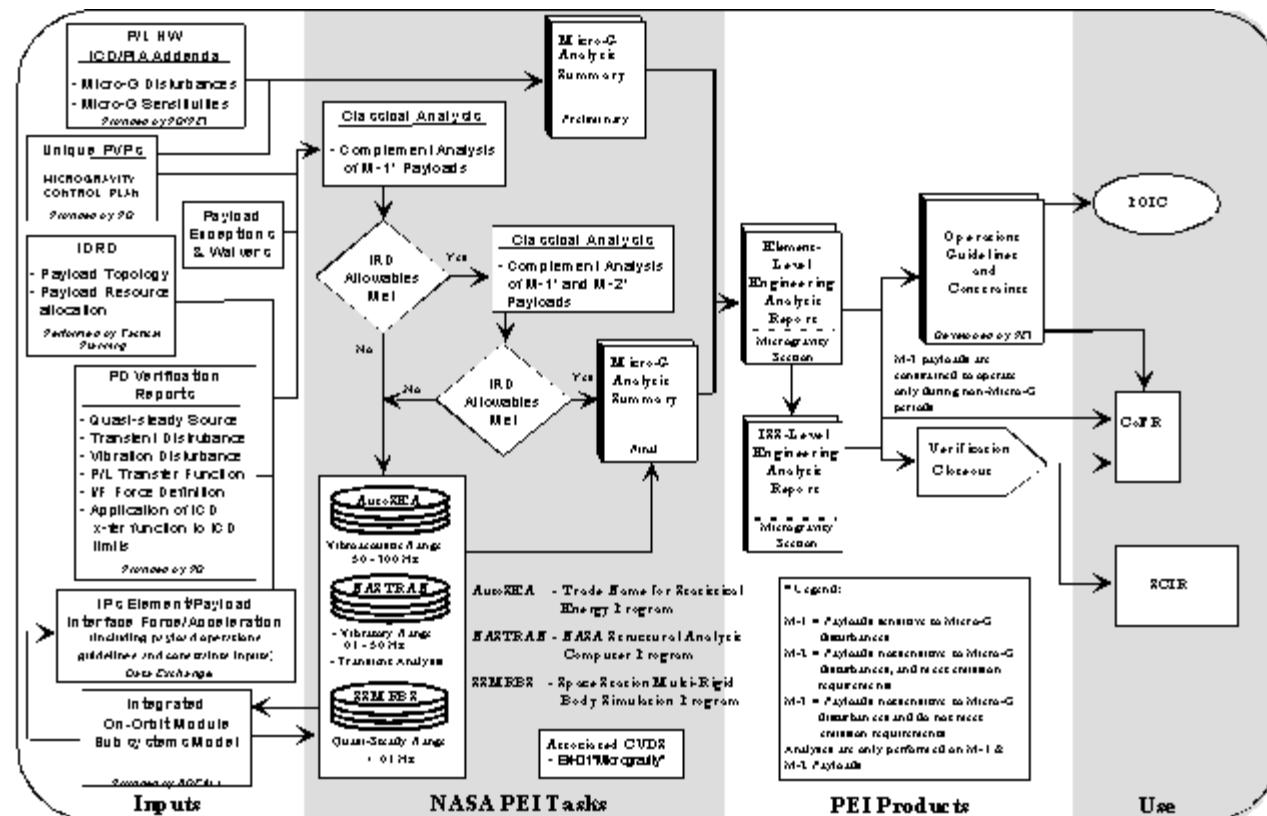


Figure 3.4.11-11: PEI Element-Level and ISS-Level Microgravity Analysis Process



## PAYLOAD ELEMENT LEVEL VERIFICATION



Verification Number EN-01	Title MICROGRAVITY	Verification Level Element & ISS	Method A		
Verification Requirement:  Provide an acceptable microgravity environment for payload complement within the limits specified in SSP 41000, paragraph 3.2.1.1.4.1 and the disturbances allocation per SSP 57000, Section 3.1.2.					
Detailed Description of Requirement:  Verify that the integrated complement of payloads meet the microgravity quasi-steady, transient, and vibratory requirements specified in SSP 57000. The integrated microgravity assessment for payloads shall be accomplished by analysis of payload data submitted to show compliance with SSP 57000 and the Unique Hardware ICD. Non-compliant data may require additional integrated ISS-level transfer function analysis. If required, and payload to payload unique transfer functions are not available, these will be generated by the Vehicle using NASA Structural Analysis Computer Program (NASTRAN) and Statistical Energy Analysis (SEA). If required for quasi-steady analysis, the vehicle may use Space Station Multi-Rigid Body Simulation (SSMRBS) Program.					
Verification Output: (Integrated microgravity structural analysis (FEM and SEA) is to be performed for Stage UF-1, Stage UF-3, and Assembly Complete only)		Submittal Dates:  1. L-15 for the Element-Level L-11 for the ISS-Level  2. L-7 for the Element-Level L-5 for the ISS-Level			
1. Preliminary Microgravity Element-Level and ISS-Level Analysis Summary addressing: <ul style="list-style-type: none"><li>• Matrix showing payloads vs. microgravity requirement indicating potential problems</li><li>• Identification of needed location-specific Vehicle Team transfer functions</li></ul> 2. Final Microgravity Element-Level and ISS-Level Analysis Summary addressing: <ul style="list-style-type: none"><li>• Updated Matrix identified above</li><li>• Vehicle Team's refined transfer functions and coupled payload analysis results</li></ul>					
Applicable Document(s) and Notes:  ISS System Verification Data SSP 41000, par. 3.2.1.1.4.1 SSP 57000; par. 3.1.2 SSP 571##; Unique PIAs, Addenda Table 1.2.4-1 and Table 2.2.1-1 SSP 572##; Unique Payload Hardware ICDs, Sec. 3.1.2 SSP 574##; Unique PVPs, EN-005 Simplified Element-To-ISS FEM Models for IPs (obtained through BDEALs) Simplified Rack-To-ISS FEM Models for Element (obtained through BDEALs)					
Continued on next page.					



## PAYLOAD ELEMENT LEVEL VERIFICATION

Continued from previous page.

Preliminary Input Data Source: 1. Unique Payloads Microgravity Control Plans (Pressurized Payload/Attached Payload-to-Element) 2. Unique Payload HDW ICDs Sec. 3.1.2 data (Pressurized Payload/Attached Payload-to-Element) 3. Unique Payload PIAs Addenda, Table 1.2.4-1 and Table 2.2.1-1. (Pressurized Payload/Attached Payload-to-Element) 4. Payload FEM or SEA Models (Pressurized Payload/Attached Payload-to-Element) 5. IP inputs (Element-To-ISS) a) Pressurized Module – Source force, rack interface force, internal ARIS rack PL force, and acceleration levels vs. frequency. Data is to be provided in one-third octave or narrow band tab separated ASCII field format b) Attached sites – TBD-18 c) Payload operations guidelines and constraints	Input Date: 1. L-22 2. L-20 3. L-18 4. L-20 5. L-15	Final Input Data Source: 1. Unique PVPs EN-005, "Microgravity Environment", final data (Pressurized Payload/Attached Payload-to-Element). 2. Payload FEM or SEA (Pressurized Payload/Attached Payload-to-Element) (if required) 3. IP inputs (Element-To-ISS) a) Pressurized Module - Source force, rack interface force, internal ARIS rack PL force, and acceleration levels vs. frequency. Data is to be provided in one-third octave or narrow band tab separated ASCII field format b) Attached sites – TBD-18 c) Payload operations guidelines and constraints 4. Payload exceptions and waivers (if any)	Input Date: 1. L-12 2. L-12 3. L-8 4. L-12
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## VEHICLE MICROGRAVITY REQUIREMENT

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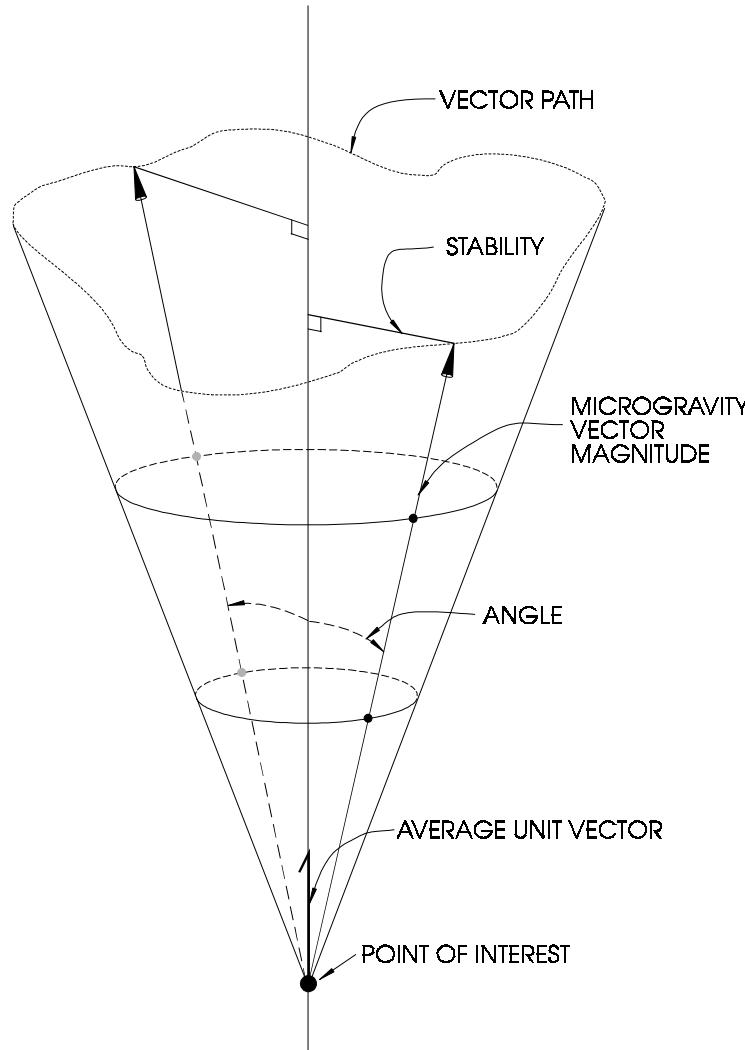
At Assembly Complete the Space Station shall provide the following microgravity acceleration performance for at least 50 percent of the internal payload locations (excluding nadir window payload location) for 180 days per year in continuous time intervals of at least 30 days:



## Assembly Complete Configuration



## Vehicle Quasi-Steady Microgravity Requirements



### Duration

- Periods:  $\geq 30$  days
- Yearly Total:  $\geq 180$  days / year

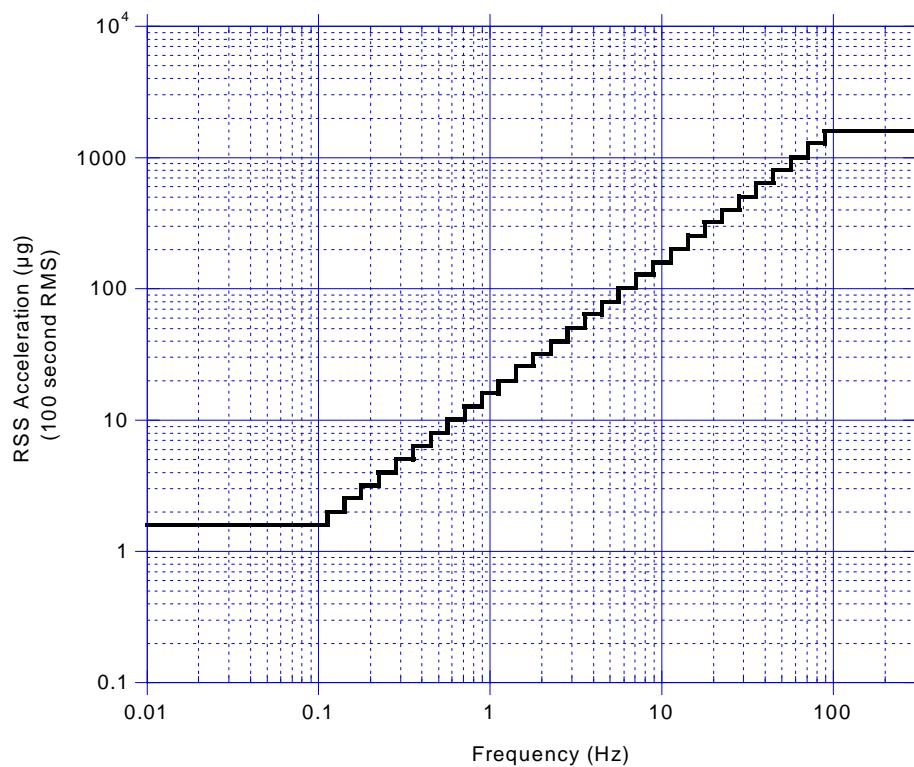
**Location - at ISPR center**

**Magnitude -  $1.0 \mu\text{g}$  ( $0 \leq f \leq 0.01 \text{ Hz.}$ )**

**Stability -  $0.2 \mu\text{g}$  perpendicular component to orbital average QS acceleration vector**



## Vehicle Vibratory Microgravity Requirements



**Duration - same as quasi-steady**

**Location - at module/ISPR interface**

**Does not include effects of crew activity. Requirements on design not crew members.**

**Combined Vibratory - per figure  
( $0.01 \leq f \leq 300.0$  Hz.)**

- **100 second root mean square average**
- **Per one-third octave band**

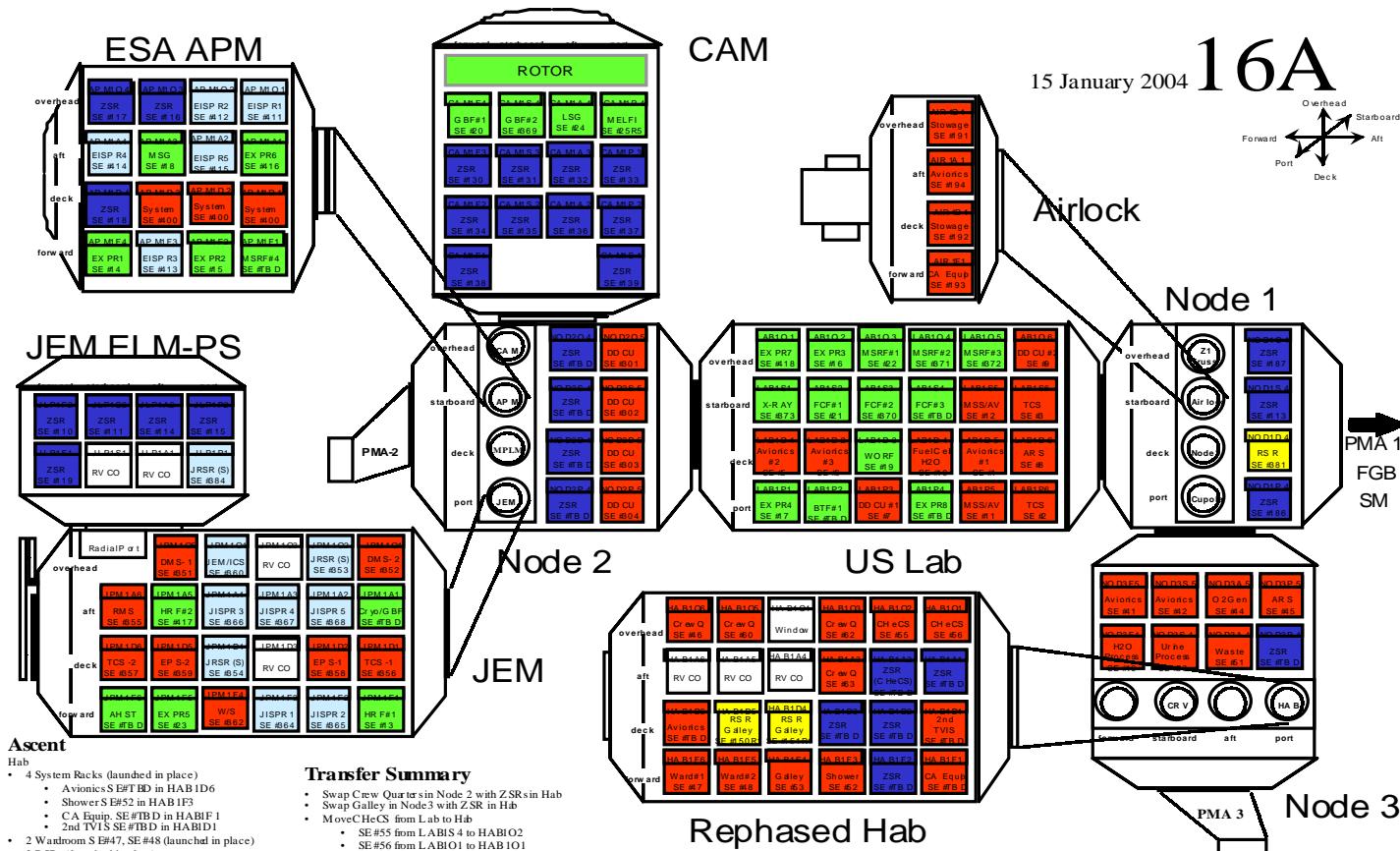
**Individual Transient**

- **1000  $\mu$ g peak per axis**
- **10  $\mu$ g\*s integrated over any 10 s interval per axis**



## Requirement Applicability

# ISPR Layout



- Hab
    - 4 System Racks (launched in place)
      - Aeronautics S#FTB D in HAB1D6
      - Showers S#FTB 5 in HAB1D2
      - CA Equip. SE+TB D in HAB1F1
      - 2nd TVIS SE#TB D in HAB1D1
    - 2 Warmdrom S#EAT, SE#4 (launched in place)
    - 2 RSK S's launched in place
      - #SE#150R1 (Gall) stowage in HAB1D6
      - #SE#151R1 (Gall) stowage in HAB1D1
    - 10 ZS PRs
    - 2 PR Is
      - MSR F#4 SE#FT B D
      - EXP RS S#FTB D
    - 3 RVCOs
    - 1 Open window

## Transfer Summary

- Swap Crew Quarters in Node 2 with Z SRs in Hab
  - Swap Galaxy in Node 3 with ZSR in Hab
  - Move CHCS from Lab to Hab
    - SE #55 from LABIS 4 to HABIO2
    - SE #56 from LABIO1 to HAB 1O1
  - Move ISPR FCF#3 from APM 1F1 to APM 1S4
  - Move ISPR MS RF #4 from Hab to APM 1F1
  - Move ISPR EXP#8 from Hab to LAB 1P4

Descent

- None

Draft 8/21/98



## PRESSURIZED PAYLOAD REQUIREMENTS

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**3.1.2.1 Quasi-Steady Requirements:** For frequencies below 0.01 Hz, Integrated racks and non-rack payloads shall limit unbalanced translational average impulse to generate less than 10 lb-s (44.8 N-s) within any 10 to 500 second period, along any ISS coordinate system vector.

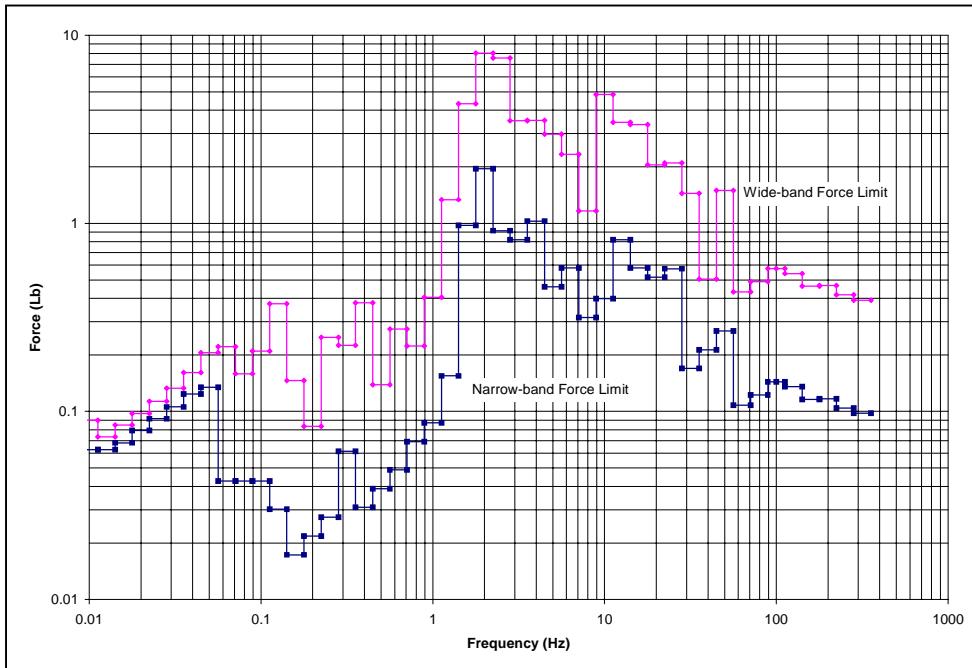
**3.1.2.2 Vibratory Requirements:** Between 0.01 and 300 Hz, Integrated Rack payloads without ARIS, inactive ARIS payloads and Non-Rack payloads shall limit vibration so that the force limits are not exceeded using the force method, or the acceleration limits are not exceeded using the acceleration method.

### **3.1.2.3 Transient Requirements:**

- Integrated racks and non-rack payloads shall limit force applied to the ISS over any ten second period to an impulse of no greater than 10 lb-s (44.5 N-s).
- Integrated racks and non-rack payloads shall limit their peak force applied to the ISS to less than 1000 lb (4448 N) for any duration.



# PRESSURIZED PAYLOAD REQUIREMENTS



Rack Interface Force Requirement

